

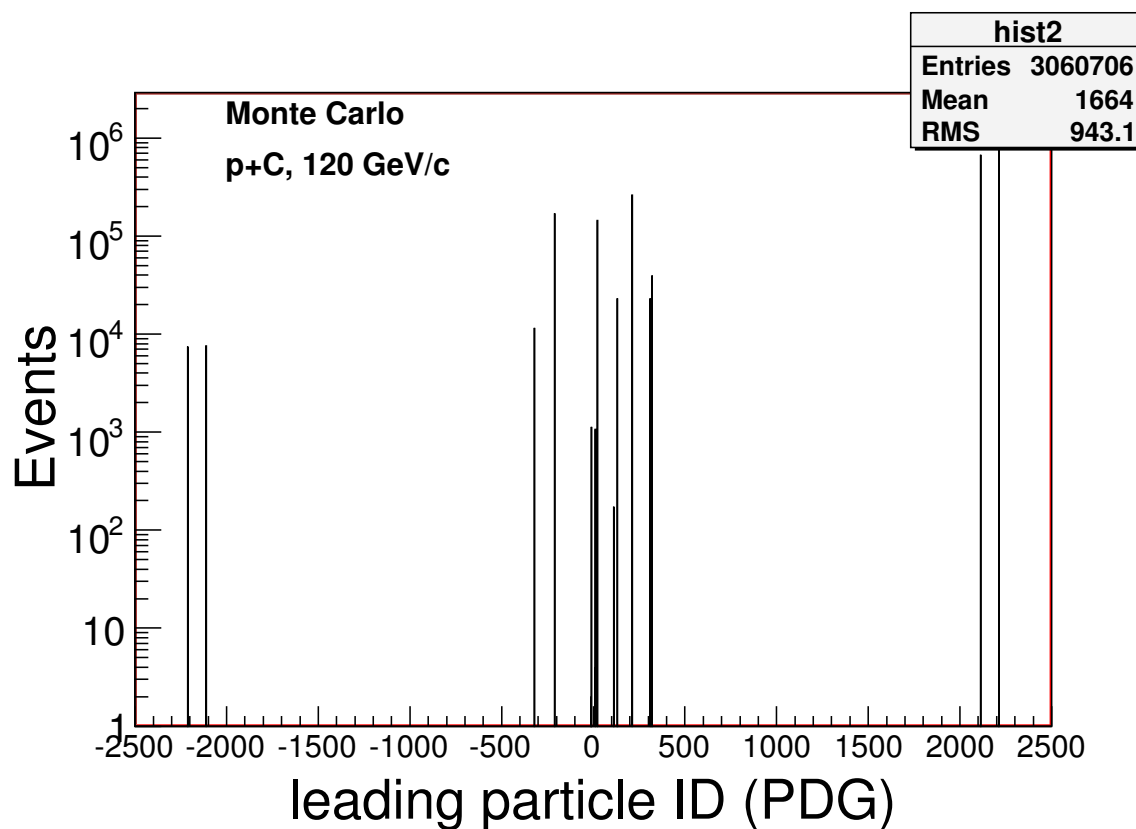
Monte Carlo Inclusive Neutron Studies

MC sample: Andre's pC interactions at 120 GeV

Unfortunately EMCAL and HCAL info is not available there.

- HCAL acceptance for neutrons
- Proton reconstruction efficiency
- K_L^0 contribution to the neutron spectrum
- γ , π^0 and K_s^0 contributions to inclusive E_{tot}

particle ID, pdg



The leading particle ID. Leading means the particle with highest momentum in generated event. PDG numbering: 11 - e^- , 13 - μ^- , 22 - γ , 111 - π^0 , 130 - K_L , ± 211 - π^\pm , ± 321 - K^\pm , 2112 - n, 2212 - p. Two spikes on right end of plot are events we needed.

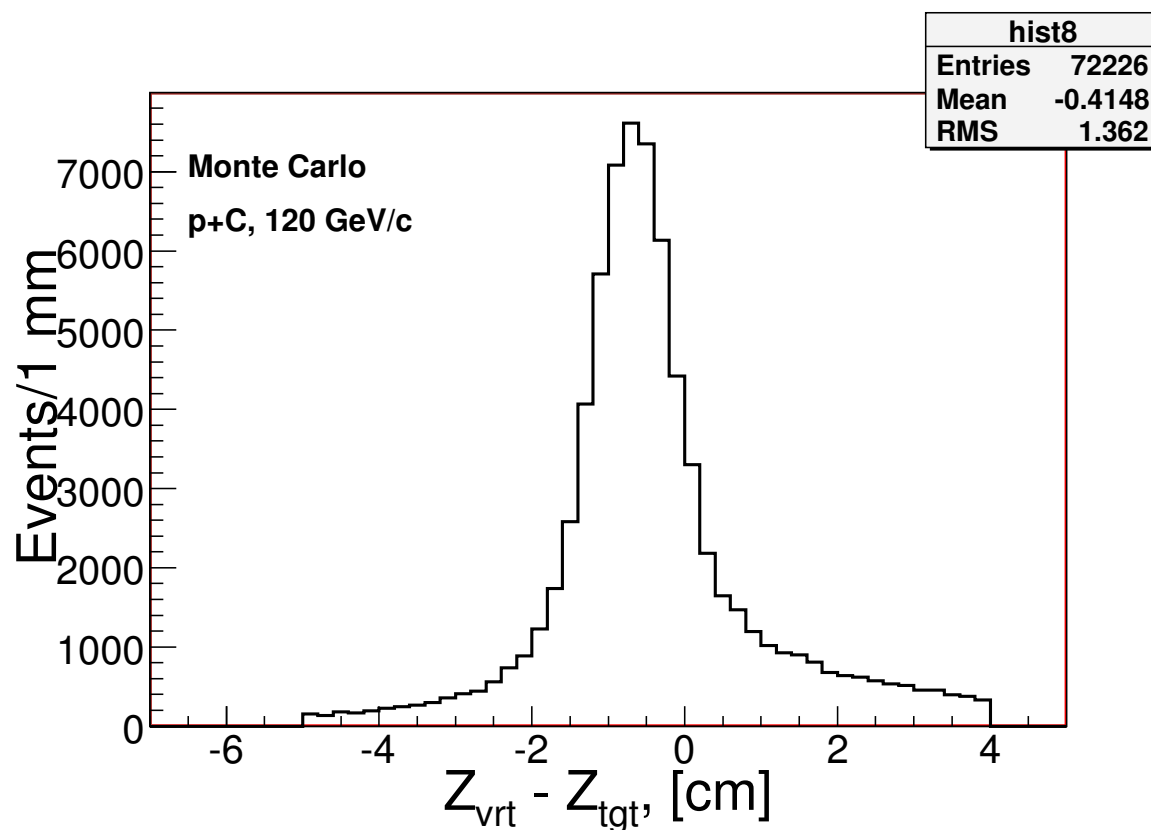
Q: What is the initial point to count the inclusive neutrons and proton?

A: Consider MC events after the vertex has been reconstructed. Our goal is the neutron to proton ratio. The one can expect that the vertex reconstruction inefficiency might be canceled.

Other requirements to MC:

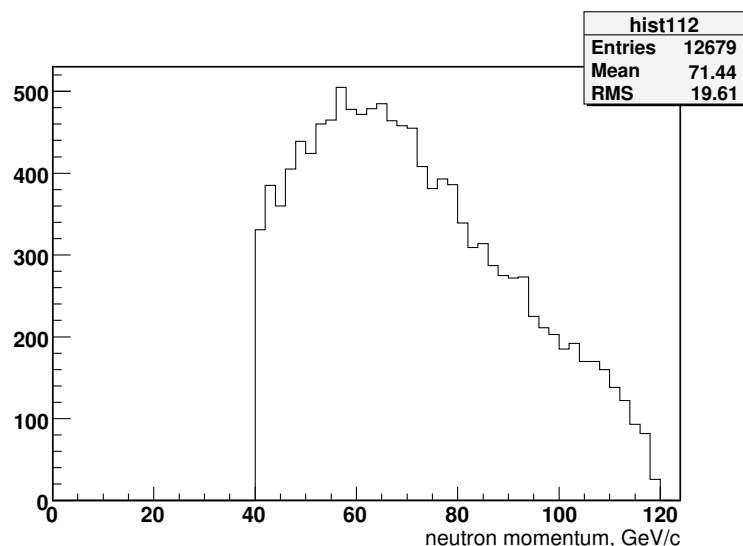
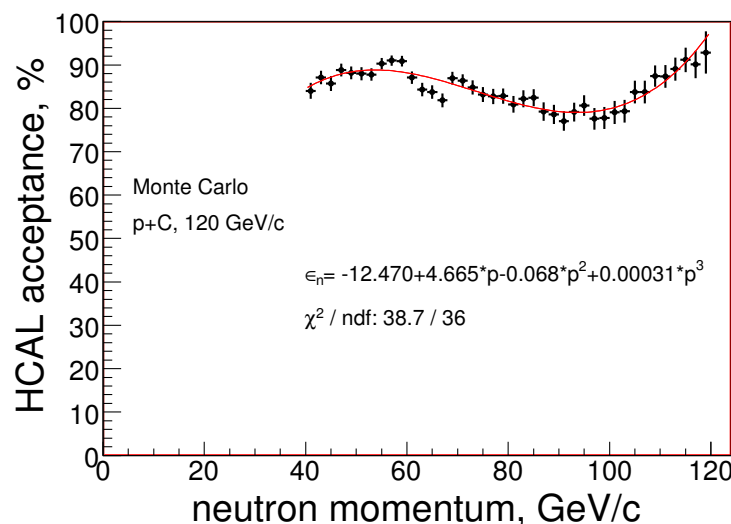
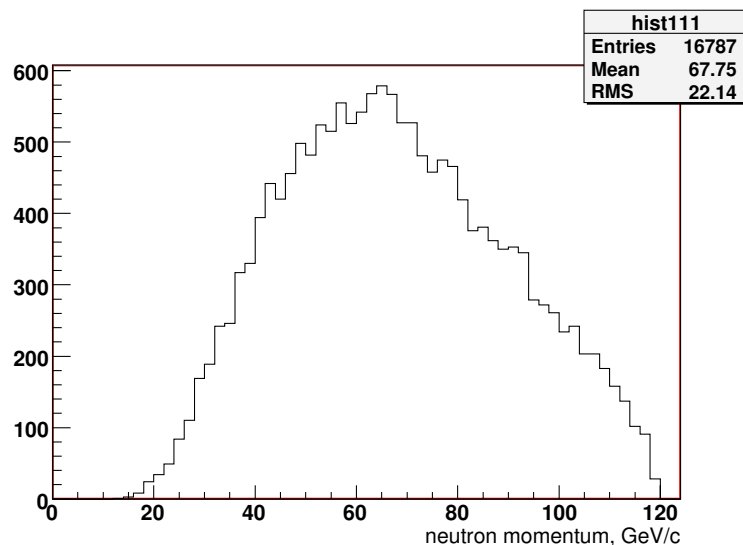
- the number of associated charged tracks: $n > 0$ for neutrons and $n > 1$ for protons
- at least one charged track with $p_{tot} > 1 \text{ GeV}/c$
- use the same analysis codes

vertex Z position



The reconstructed vertex Z position distribution. Data: Monte Carlo p+C interactions at 120 GeV/c. The vertex reconstruction efficiencies: $\epsilon_n = 0.050 \pm 0.003$ and $\epsilon_p = 0.045 \pm 0.002$. The distribution indicates that the trigger counter is missed in MC.

HCAL acceptance for inclusive neutrons

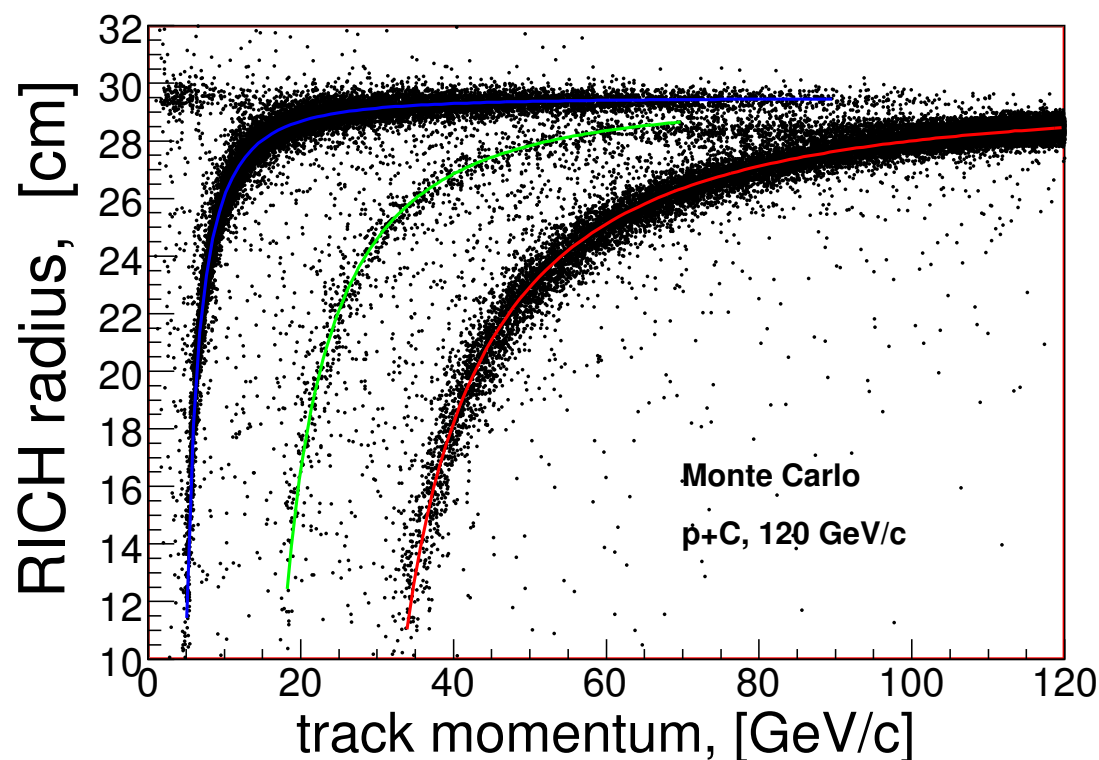


Top left plot - neutron momentum distribution. The neutron momentum value based on Monte Carlo truth info. This plot is a denominator.

Bottom left plot - neutron momentum distribution for events which passed the inclusive neutron requirements and neutron pointing into HCAL fiducial, where momentum value again is MC truth info. This plot is a numerator.

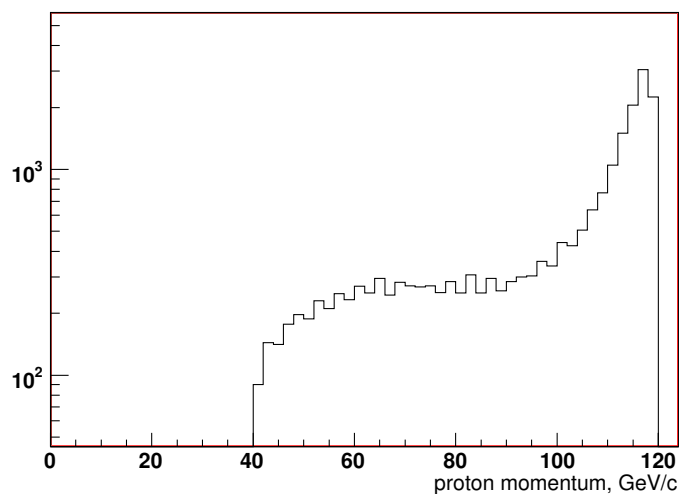
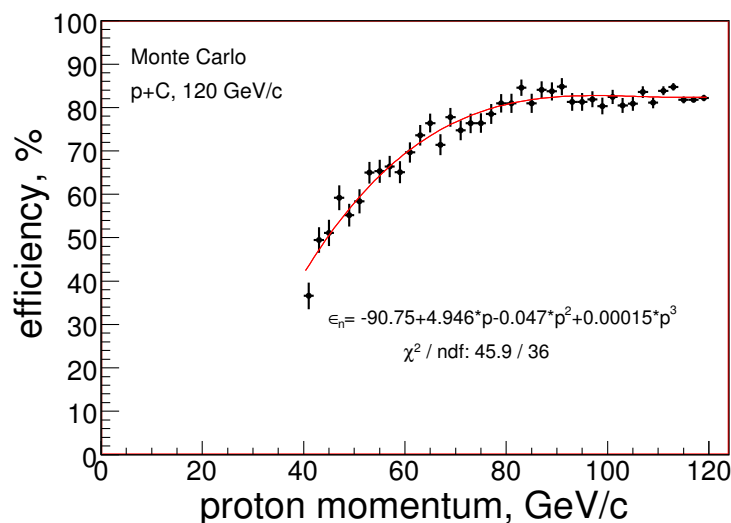
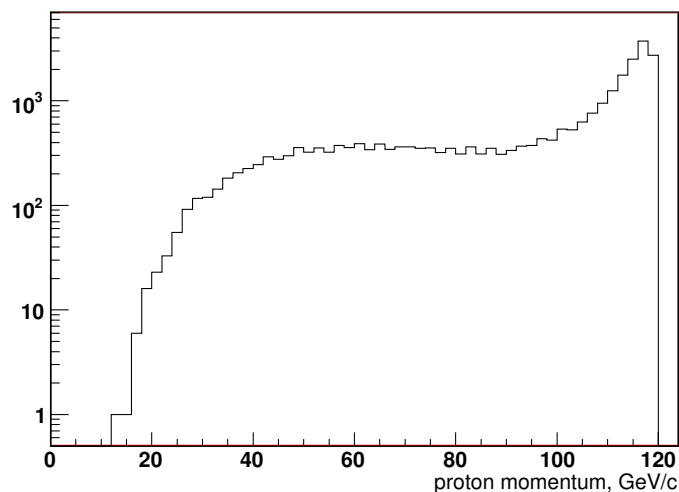
Top right plot - HCAL acceptance vs the neutron momentum. Will use the fit parameters to update N_n in data.

proton identification



Plot illustrates RICH performance on Monte Carlo data. RICH detector simulation is pretty much close to data. The momentum value based on the truth info. The Monte Carlo leading proton required to be identified by RICH: select within ± 1.2 cm around of the red curve.

inclusive proton reco efficiency

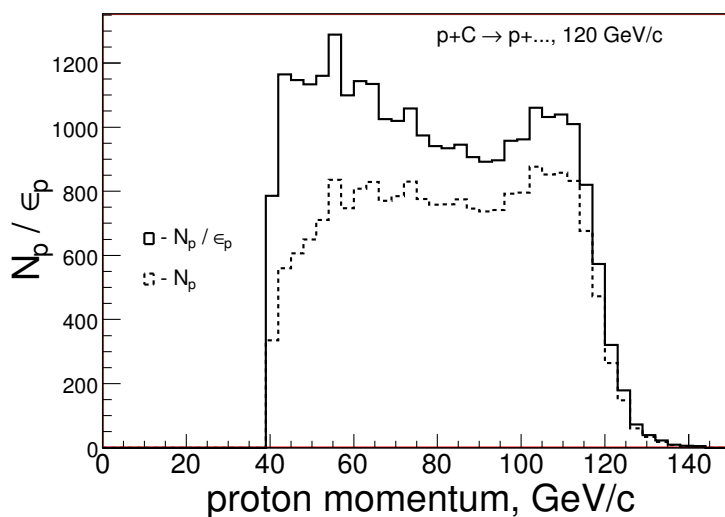
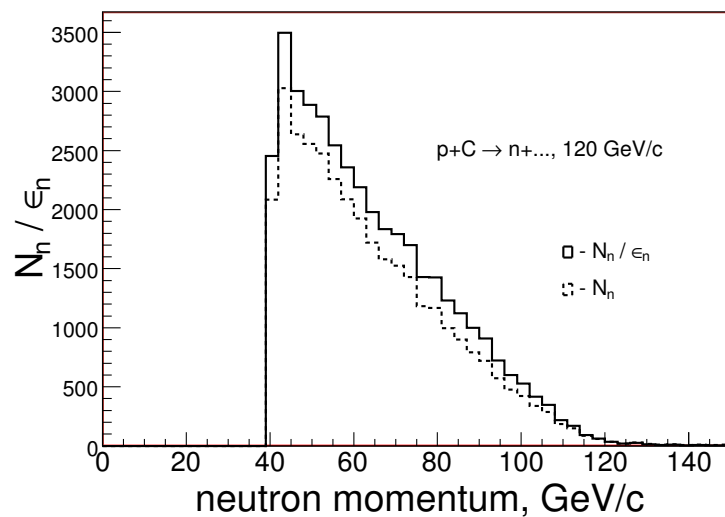


Top left plot - proton momentum distribution. The proton momentum value based on Monte Carlo truth info. This plot is a denominator.

Bottom left plot - proton momentum distribution for events which passed identification, the inclusive proton requirements and proton pointing into HCAL fiducial. This plot is a numerator.

Top right plot - ϵ_p vs the proton momentum. Will use the fit parameters to update N_p in data.

final N_n and N_p , real data



HCAL acceptance for neutrons, ϵ_n , and proton combined reco efficiency and probability to be within HCAL fiducial, ϵ_p , were found from fit:

$$\epsilon_n = -12.47 + 4.66p - 0.068p^2 + 0.00031p^3,$$

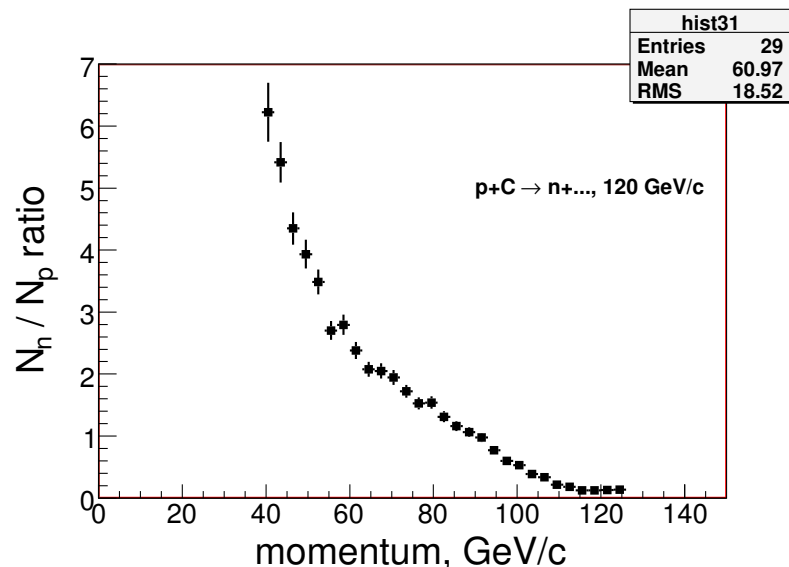
$$\epsilon_p = -90.75 + 4.95p - 0.047p^2 + 0.00015p^3,$$

where ϵ_n and ϵ_p converted from % to 0-1 range. The final N_n and N_p were calculated as:

$$N_{n,new} = N_n / \epsilon_n, \quad N_{p,new} = N_p / \epsilon_p$$

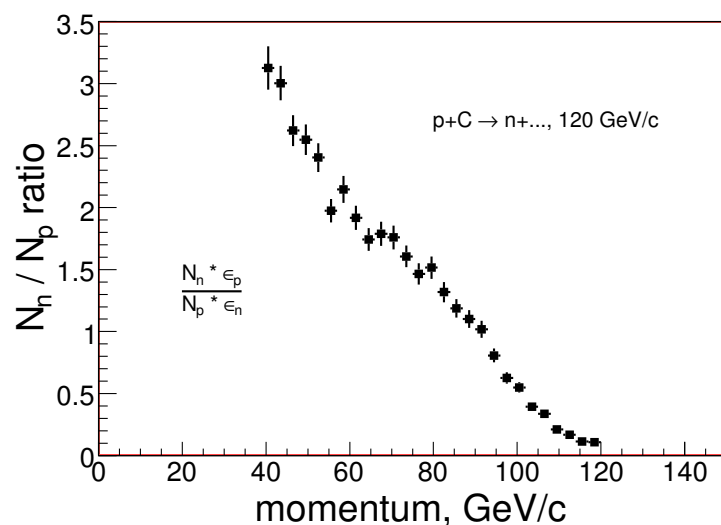
Left plots illustrates the inclusive neutron (top plot) and proton (bottom) distributions in real data, where the solid line plots are the final and dashed - before corrections applied. The target-out data already has been subtracted.

N_n / N_p ratio: before and now



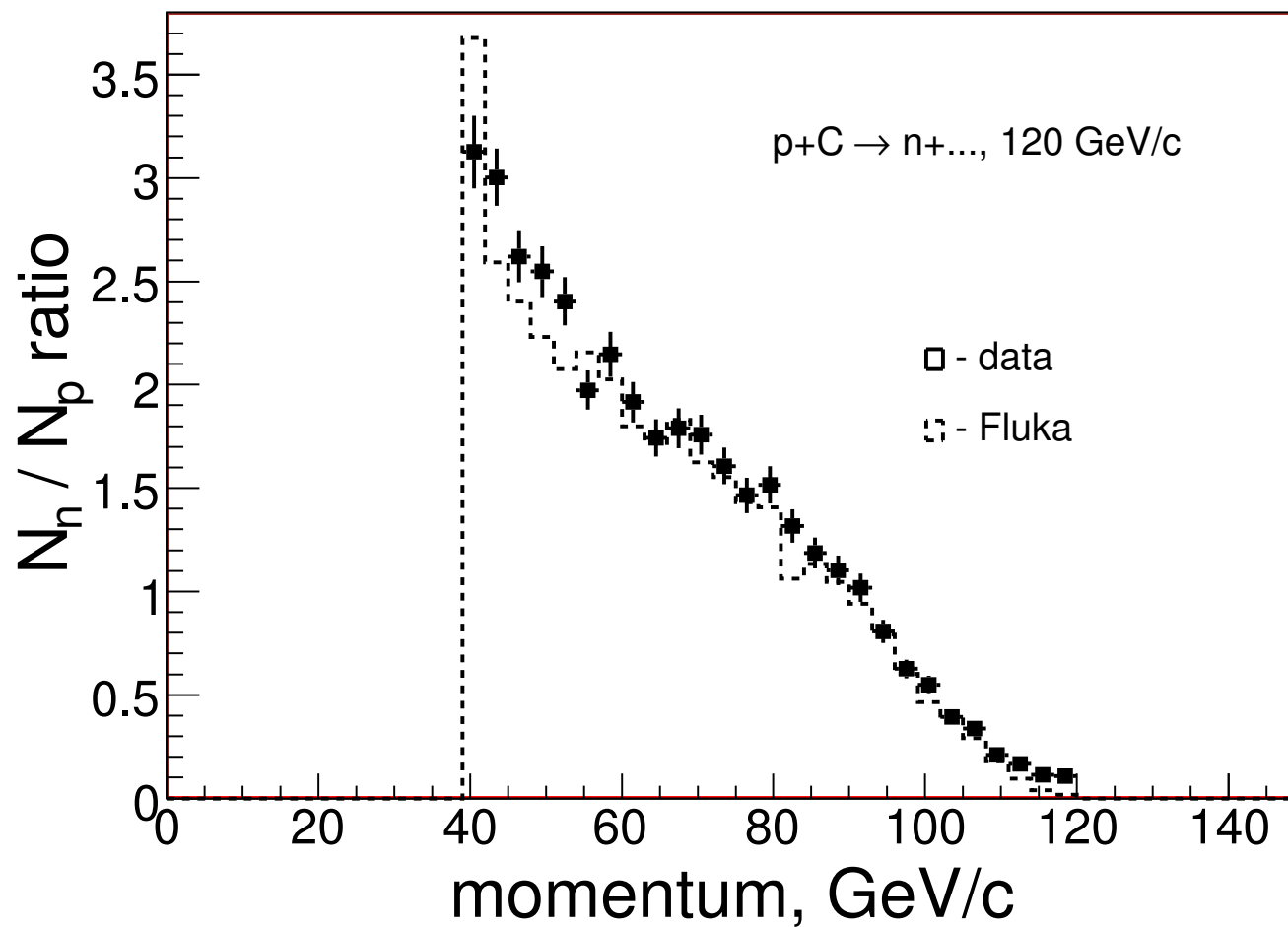
N_n and N_p are from p+C interactions at 120 GeV/c, real data

Top plot illustrates how the N_n / N_p ratio looks like before any corrections applied.

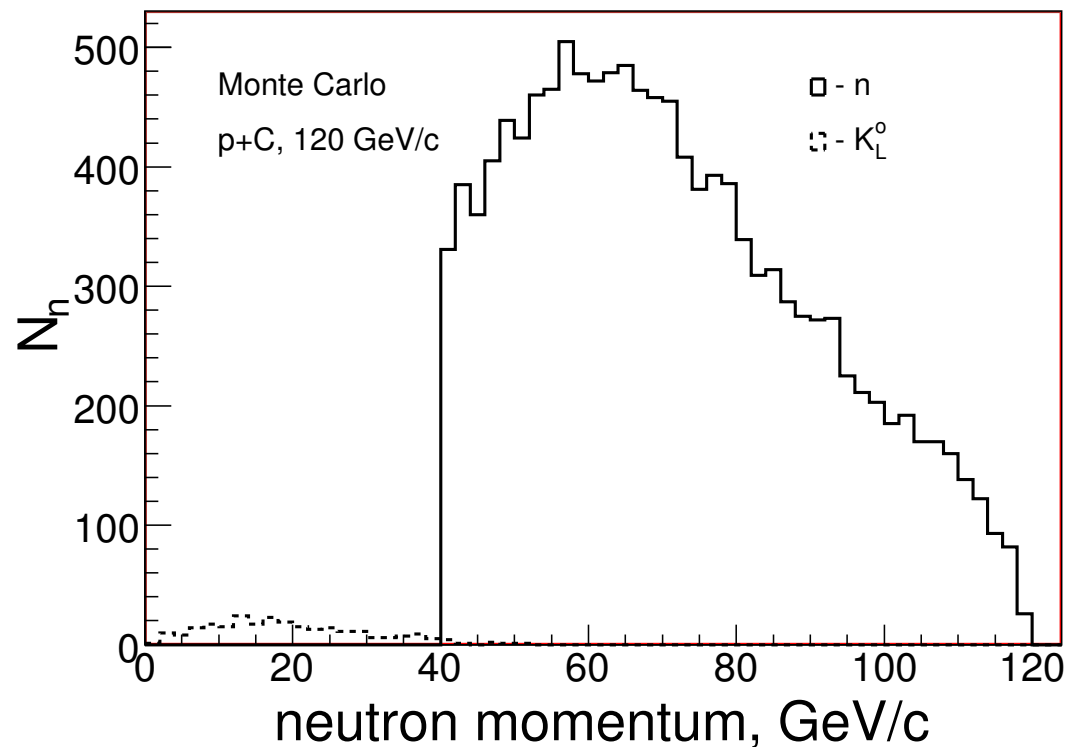


Bottom plot - the final N_n / N_p ratio when HCAL acceptance and proton reconstruction inefficiency has been taken in account.

N_n / N_p ratio: data vs Fluka



K_L^0 contribution



The solid line plot is the inclusive neutron momentum distribution, it is same as numerator plot on page 5. The dashed plot illustrates the distribution of the most highest momentum of K_L^0 which associated with the inclusive neutron and it is within HCAL fiducial.

summary

Monte Carlo data allowed to:

- calculate the HCAL acceptance for the inclusive neutrons
- find the proton reconstruction efficiency
- calculate the final n/p ratio in data
- find that K_L^0 contribution is negligible
- compare n/p ratio in data vs Fluka. They appeared to be consistent